ATTACHMENT 2: Chemical Additives

Mine Site

Chemical	Purpose	Location of Chemical in Process	Amount, Duration, Frequency of Addition	Average Rate of Use	Maximum Rate of Use
Magnesium Chloride Aqueous Solution (Dustguard)	Dust Suppressant	Mine Site: Haul roads and stockpiles, if needed	2 -3 times/year	104,428 gallons/day 208,856 gallons/yr	104,428 gallons/day 313,284 gallons/yr
Calcium Chloride	De-icer	Walkways, haul roads	As needed	N/A	TBD based on recommended application rates

Wastewater Treatment System

Chemical	Purpose	Location of Chemical in Process	Amount, Duration, Frequency of Addition	Average Rate of Use	Maximum Rate of Use
Sodium Permangate Solution	Filter Pretreatment	Tailings Basin Seepage Treatment Train greensand filter	Continuous	57 pounds/day	230 pounds/day
Sodium Permangate Solution	Filter Pretreatment	Mine Water Treatment Trains greensand filter	Continuous	12 pounds/day	15 pounds/day
Carbon Dioxide	pH Adjustment	Tailings Basin Seepage Train Secondary Membranes	Continuous	5 tons/day	10 tons/day
Carbon Dioxide	pH Adjustment	Re-carbonation at mine water treatment trains & secondary membranes at mine water treatment trains	Continuous	5 tons/day	5 tons/day
Hydrated Lime	pH Adjustment	HDS metals removal at mine water treatment trains.	Continuous	5 tons/day	5 tons/day
Hydrated Lime	pH Adjustment	Sulfate removal at mine water treatment trains	Continuous	5 tons/day	6 tons/day
Hypersperse MSI410 (Suez)	Membrane Deposit Control Agent	Tailings Basin Seepage Train Primary Membranes	Continuous	59 pounds/day	65 pounds/day
Hypersperse MSI410 (Suez)	Membrane Deposit Control Agent	Mine Water Treatment Trains Primary Membranes	Continuous	11 pounds/day	12 pounds/day
NLR 759	Phosphoric Acid Antiscalant	Tailings Basin Seepage Treatment Train Secondary Membranes	Continuous	3 gallons/day	3 gallons/day

Wastewater Treatment System

Chemical	Purpose	Location of Chemical in Process	Amount, Duration, Frequency of Addition	Average Rate of Use	Maximum Rate of Use
NLR 759 (Primary)	Phosphoric Acid Antiscalant	Mine Water Treatment Trains Secondary Membranes	Continuous	4 gallons/day	4 gallons/day
Sodium Bisulfate	Oxidant-Quenching Membrane Pre-treatment	Tailings Basin Seepage Treatment Train Primary Membranes	Continuous	27 pounds/day	39 pounds/day
Sodium Bisulfate	Oxidant-Quenching Membrane Pre-treatment	Tailings Basin Seepage Treatment Train Secondary Membranes	Continuous	7 pounds/day	7 pounds/day
Sodium Bisulfate	Oxidant-Quenching Membrane Pre-treatment	Mine Water Treatment Trains Primary Membranes	Continuous	5 pounds/day	6 pounds/day
Sodium Bisulfate	Oxidant-Quenching Membrane Pre-treatment	Mine Water Treatment Trains Secondary Membranes	Continuous	3 pounds/day	3 pounds/day
Kleen MCT103 (Suez)	Low pH Reverse Osmosis Membrane Cleaner	Tailings Basin Seepage Treatment Train Secondary Membranes	Continuous	7,500 pounds/year	8,000 pounds/year
Kleen MCT103 (Suez)	Low pH Reverse Osmosis Membrane Cleaner	Mine Water Treatment Trains Primary Membranes	Continuous	1,600 pounds/year	1,600 pounds/year
Kleen MCT515 (Suez)	High pH Membrane Cleaner	Tailings Basin Seepage Treatment Train Secondary Membranes	Continuous	7,500 pounds/year	8,000 pounds/year
Kleen MCT515 (Suez)	High pH Membrane Cleaner	Mine Water Treatment Trains Primary Membranes	Continuous	1,600 pounds/year	1,600 pounds/year
NLR 404	Organic Acid Membrane Cleaner	Tailings Basin Seepage Treatment Train Secondary Membranes	Continuous	10 gallons/day	11 gallons/day
NLR 404	Organic Acid Membrane Cleaner	Mine Water Treatment Trains Secondary Membranes	Continuous	9,000 gallons/year	9,000 gallons/year
NLR 505	Alkaline surfactant Membrane Cleaner	Tailings Basin Seepage Treatment Train Secondary Membranes	Continuous	10 gallons/day	11 gallons/day
NLR 505	Alkaline surfactant Membrane Cleaner	Mine Water Treatment Trains Secondary Membranes	Continuous	9,000 gallons/year	9,000 gallons/year
Granular Calcite	Effluent Stabilization	Tailings Basin Seepage Treatment Train Limestone Contactor	Continuous	900 pounds/day	2,000 pounds/day

Sewage Treatment Plant & Plant Site Water Treatment

Chemical	Purpose	Location of Chemical in Process	Amount, Duration, Frequency of Addition	Average Rate of Use	Maximum Rate of Use
Magnesium Chloride Aqueous Solution (Dustguard)	Dust Suppressant	Haul roads	2 -3 times/year	98,323 gallons/day 128,691 gallons/yr	98,323 gallons/day 296,469 gallons/yr
Calcium Chloride	De-icer	Walkways, haul roads	As needed	N/A	TBD based on recommended application rates
BT-205W Anionic / Nonionic Surfactant Blend	Dust suppressant	Conveyor transfer points	1 time/year as needed	N/A	
Aluminum Sulfate, 50% Solution	Coagulant	Flocculator	Continuous	47 pounds/day 17,155 pounds/yr	190 pounds/day 69,350 pounds/yr
Potassium Permangate	Oxidant	Flocculator	Continuous	12 pounds/day 4,380 pounds/yr	74 pounds/day 27,010 pounds/yr
Ammonia	Disinfectant (Chloramines)	Clearwell	Continuous (as needed)	0.07 pounds/day 25.55 pounds/yr	02 pounds/day 73 pounds/yr
Chlorine	Disinfectant	Filter and CLearwell	Continuous	0.8 pounds/day 292 pounds/year	2.5 pounds/day 912.5 pounds/year
Liquid Alum	Coagulant	Sewage Treatment System Stabilization Ponds	3 times/year as needed	90 gallons/year	150 gallons/year

Tailings Basin

Chemical	Purpose	Location of Chemical in Process	Amount, Duration, Frequency of Addition	Average Rate of Use	Maximum Rate of Use
Lime Slurry (Primary)	pH Modifier: Used to regulate pH in the flotation circuit	Flotation Circuit, specifically the Separation Cleaner Flotation Cells	Continuous	28.15 tons/day 10,274 tons/yr	41.10 tons/day 15,000 tons/yr
MIBC (Methyl Isobutyl Carbinol, 100% Solution) (Primary)	Frother: Used to improve stability of froth bubbles as they rise through the flotation cells	Flotation Circuit, specifically the Flotation Roughers, Scavengers, and Cleaner Flotation Cells	Continuous	2.88 tons/day 1,050 tons/yr)	4.11 tons/day 1,500 tons/yr)

Tailings Basin

Chemical	Purpose	Location of Chemical in Process	Amount, Duration, Frequency of Addition	Average Rate of Use	Maximum Rate of Use
SIPX (Sodium Isopropyl Xanthate) (Primary)	Collector: Selectively adsorb minerals based on hydrophobicity of the collector & mineral	Flotation Circuit, specifically the Flotation Roughers, Scavengers, and Cleaner Circuit	Continuous	2.74 tons/day (1,000 tons/yr)	4.79 tons/day (1,750 tons/yr)
CMC (Carboxyl Methyl Cellulose Tennapress PE26) Primary	Flocculant: Used to depress gangue minerals in flotation cells to improve selectivity towards Cu Ni minerals	Flotation Circuit, specifically Rougher and Pyrhotite Cleaner Flotation Cells	Continuous	3.29 tons/day 1,200 tons/yr	4.79 tons/day 1,750 tons/year
Copper Sulfate Pentahydrate (Primary)	Activator: Used to increase the available adsorption sites on the mineral to allow for adsorption by the collector	Flotation Circuit, specifically the Scavenger Cells	Continuous	1.71 tons/day 625 tons/yr	2.05 tons/day 750 tons/yr
MagnaFloc 10 (Primary)	Flocculant: Promote flocculation of suspended particles in liquors	Flotation Circuit, specifically the Concentrate Thickeners	Continuous	0.082 tons/day 30 tons/yr	0.14 tons/day 50 tons/year

Hydrometallurgical Plant & Hydrometallurgical Residue Facility

Chemical	Purpose	Location of Chemical in Process	Amount, Duration, Frequency of Addition	Average Rate of Use	Maximum Rate of Use
Sodium Hydrosulfide, 30% Solution (Primary)	Cementation of copper from solution as copper sulfide	Hydromet, specifically copper cementation	Continuous	3.17 tons/day 1,160 tons/year	4.10 tons/day 1,750 tons/year
Caustic Soda (Sodium Hydroxide, 50% Solution)	Increase pH of off-gases by removing traces of H2S and S02 in vent scrubbers	Hydromet, specifically the plant scrubber	Continuous	57.53 gallons/day 21,000 gallons/yr	82.19 gallons/day 30,000 gallons/yr
Sulfuric Acid, 93% Solution	Used as wash water for leach residue filter	Hydromet, specifically the residue filter wash water	Continuous	0.47 tons/day 170 tons/yr	0.68 tons/day 250 tons/yr
Hydrochloric Acid, 32% Solution	Addition of chloride used to promote mineral leaching	Hydromet, specifically the autoclave	Continuous	13.70 tons/day 5,000 tons/yr	20.55 tons/day 7,500 tons/yr
MagnaFloc 342	Flocculation: Promote flocculation of suspended particles in liquors	Hydromet, specifically mixed hydroxide precipitation	Continuous	0.06 tons/day 21 tons/yr	0.11 tons/day 40 tons/yr

Hydrometallurgical Plant & Hydrometallurgical Residue Facility

Chemical	Purpose	Location of Chemical in Process	Amount, Duration, Frequency of Addition	Average Rate of Use	Maximum Rate of Use
MagnaFloc 351	Flocculation: Promotes flocculation of suspended particles in liquors	Hydromet, specifically in the leach residue thickener, PGM thickener, and copper sulfide cementation thickener	Continuous	0.27 tons/day 100 tons/yr	0.41 tons/day 150 tons/yr
Sulfur Dioxide (Liquid)	Reduce ferric ions to ferrous ions	Hydromet, specifically iron reduction and PGM precipitation	Continuous	4.14 tons/day 1,510 tons/yr	6.16 tons/day 2,250 tons/yr
Limestone (Lump)	Promote precipitation of Fe and Al	Hydromet, specifically in iron removal	Continuous	276.71 tons/day 101,000 tons/yr	410.96 tons/day 150,000 tons/yr
Limestone (Ground) (Potential substitute)	Promote precipitation of Fe and Al	Hydromet, specifically in iron removal	Continuous	276.71 tons/day 101,000 tons/yr	410.96 tons/day 150,000 tons/yr
Magnesium Hydroxide, 60% Slurry	Promote precipitation of Ni and Co sulfates as Ni and Co hydroxides (mixed hydroxide precipitate)	Hydromet, specifically mixed hydroxide precipitation	Continuous	16.44 tons/day 6,000 tons/yr	24.66 tons/day 9,000 tons/yr
Magnafloc 155	Flocculant: Promote flocculation of suspended particles in liquors	Hydromet, specifically mixed hydroxide precipitation	Continuous	0.11 tons/day 40 tons/year	0.21 tons/day 75 tons/year

Transportation and Utility Corridor

Chemical	Purpose	Location of Chemical in Process	Amount, Duration, Frequency of Addition	Average Rate of Use	Maximum Rate of Use
Magnesium Chloride Aqueous Solution (Dustguard)	Dust Suppressant	Haul roads and stockpiles, if needed	2 -3 times/year	49,339 gallons/day 98,678 gallons/yr	49,339 gallons/day 148,017 gallons/yr
Calcium Chloride	De-icer	Walkways, haul roads	1 time/year as needed	N/A	TBD